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**Overview of Methodology for
Incorporating Climate Change
in BDCP Impact Assessments**

BDCP Steering Committee

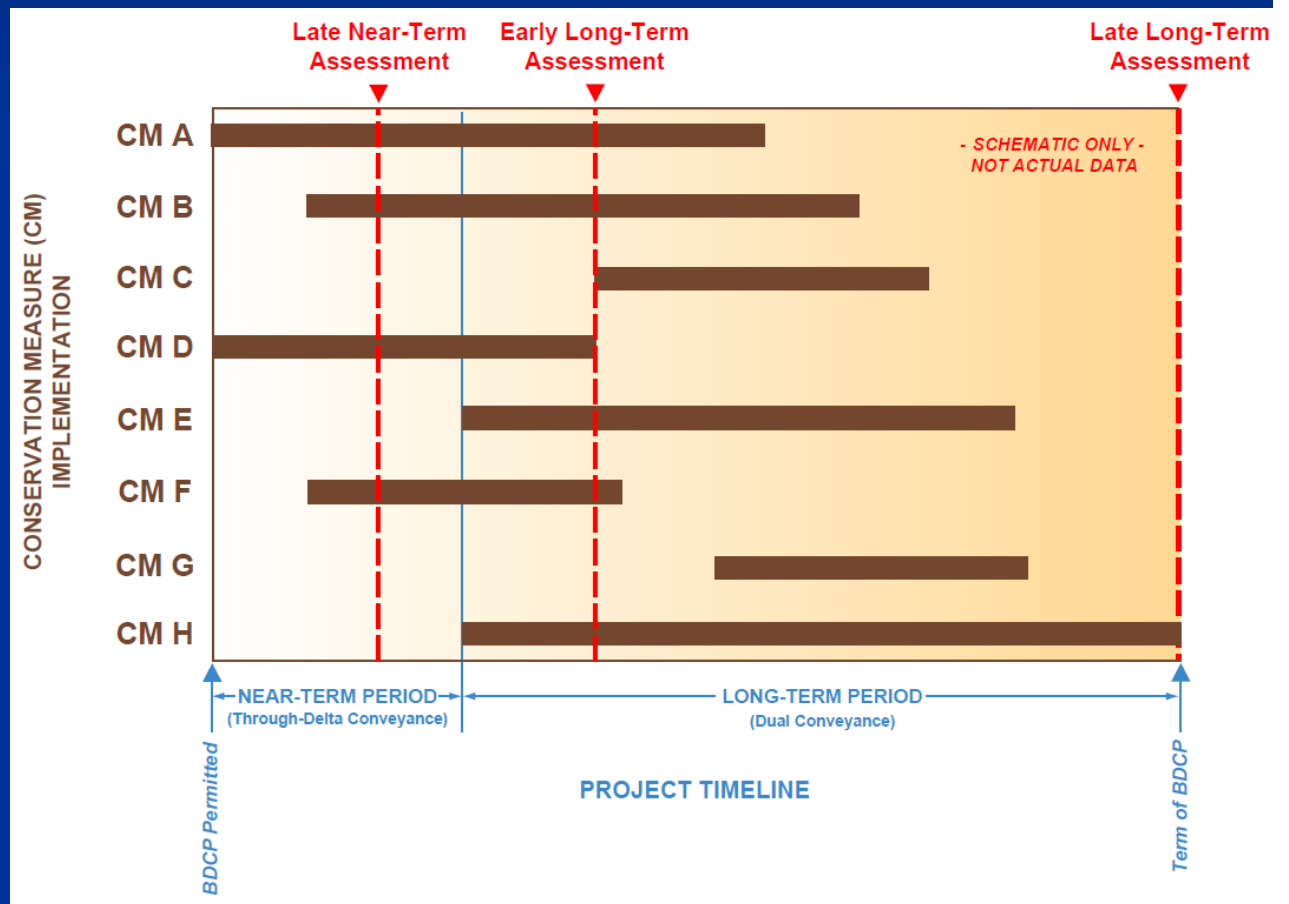
October 22, 2009

BDCP Impacts and Effects Analyses

- Coordinated effort between state (DWR, DFG) and federal (Reclamation, FWS, and NMFS) agencies
- Analytical processes and tools to support 4 environmental documents:
 - HCP/NCCP
 - EIR/S
 - Biological Assessment
 - Biological Opinions

BDCP Assessment Points in Time

- Process seeks permit for a 50-yr period
- Quantitative analysis to be prepared for disclosure of impacts/effects at three points in time
- Approximately 2015, 2025, and 2060



Key Projected Climate Changes

- Global and regional warming
- Changes in precipitation: form, timing, and quantity
- Changes in runoff quantity and timing
- Sea level rise

Potential Climate Change Impacts to BDCP Elements

Delta Marsh Habitat

- Broader area of inundation, upland migration
- Deeper water with increased predation pressures
- Salinity changes effects on vegetation and macro-invertebrate communities
- Changes to thermal refugia
- Changes to invasive species dynamics

Anadromous Fish Habitat (upstream)

- Changes to hydrograph and temperature
- Changes to spawning habitat/holding pools
- Timing of spawning and outmigration (life cycle impacts)
- Increased floodplain inundation

Reservoir and Conveyance Facility Management

- Coldwater pool management
- Challenges to flood control operations
- Salinity changes and management
- Timing of water availability for export
- Changes to water supply reliability

Water Quality

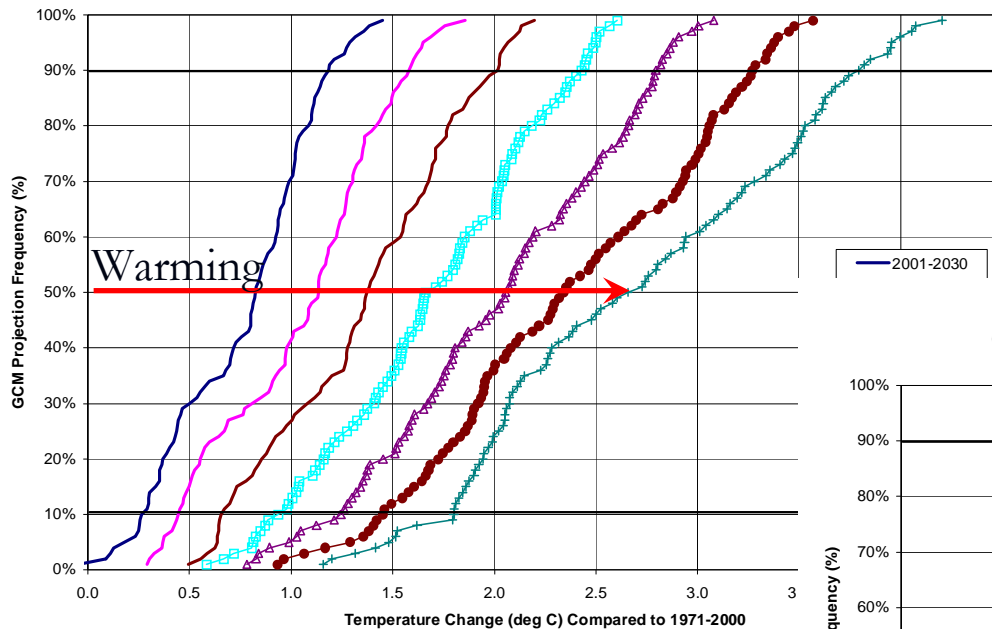
- Increased Delta salinity intrusion due to sea level rise, levee system failure/island flooding
- Changes to hydrodynamics and mixing
- Increased water temperatures
- Changes to dissolved oxygen
- Effects on water treatment and human health

Previous State and Federal Efforts to Incorporate Climate Change in California

- California Climate Action Team Reports, 2006
 - DWR Progress on Incorporating Climate Change
- Salton Sea Ecosystem Restoration Program, PEIR, 2007
- State Water Project Reliability Report, 2007
- Monterey Plus Amendment, EIR, 2007
- Operations Criteria and Plan, 2008
 - USFWS Delta Smelt Biological Opinion, 2008
 - NMFS Salmon Biological Opinion, 2009
- California Climate Action Team Reports, 2009
- Delta Risk Management Strategy, 2009
- Delta Vision, 2009
- BCDC Living with a Rising Bay: Vulnerability and Adaptation Report, 2009
- California Water Plan, On-going
- San Joaquin River Restoration Program, EIS, On-going
- USACE SF Bay to Stockton NIP, EIS, On-going

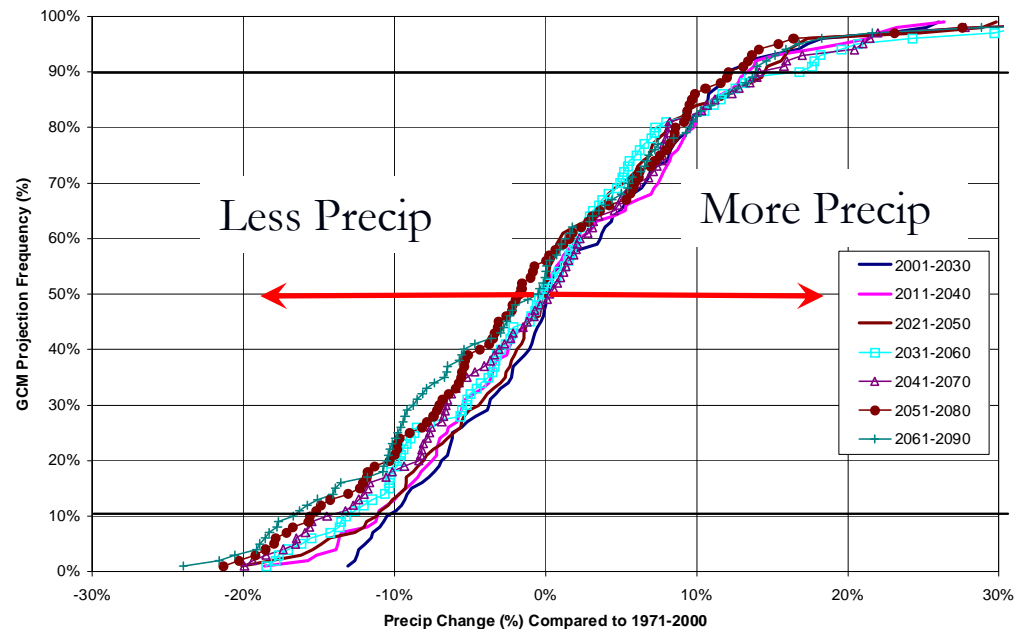
What do the Climate Models Show?

Projected Annual Temperature Change (Sacramento only)
Cumulative Distribution Frequency (112 Emission-Climate Model Projections)



- Temperature signal is strong and temporally-consistent

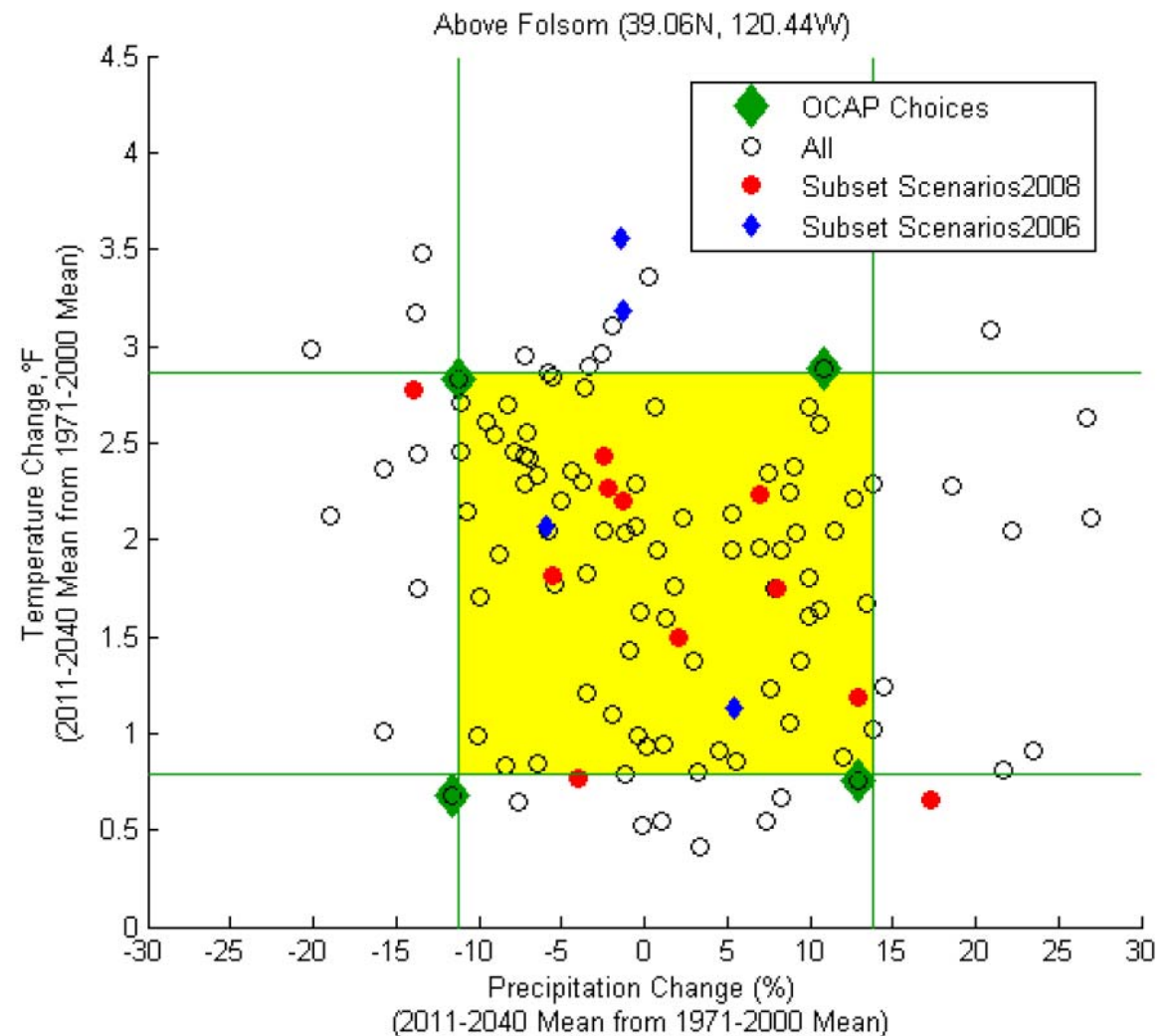
Projected Annual Precipitation Change (Sacramento only)
Cumulative Distribution Frequency (112 Emission-Climate Model Projections)



- Precipitation projections are not directionally consistent
- Multi-decadal variability complicates period analysis

Comparison of OCAP and CAT Scenarios

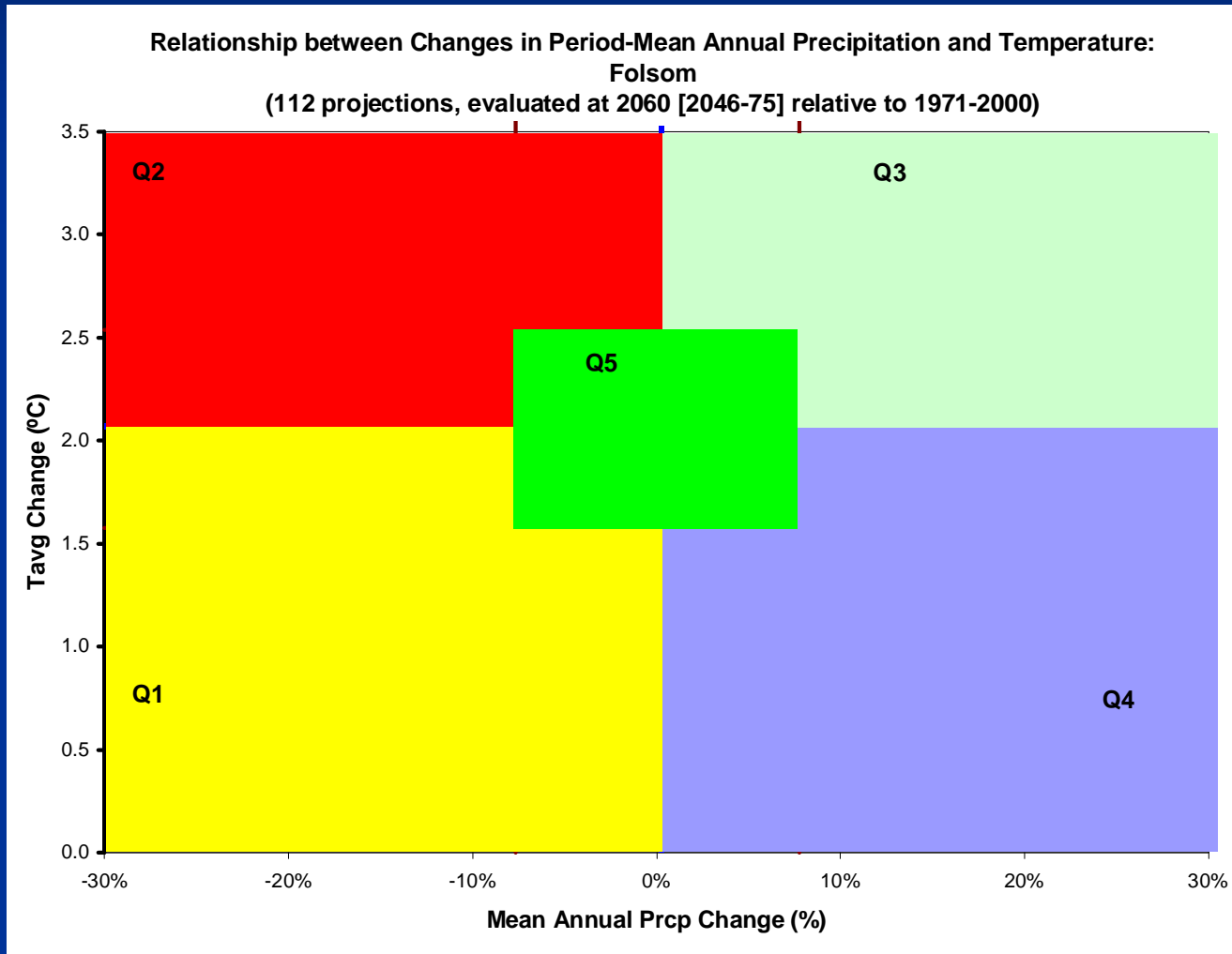
- At least 112 GCM-emission scenario projections have been downscaled and are available
- OCAP selected range based on 10th and 90th percentile of annual ΔT and ΔP
- CAT scenarios selected based on output availability and historical performance



Regional Climate Change Scenario Selection Criteria

1. Select a range of scenarios to reflect the uncertainty with GCM projections and emission scenarios;
2. Select scenarios that reduce the “noise” inherent with any particular GCM projection;
3. Select an approach that incorporates both the mean climate change trend and changes in variability; and
4. Select time periods that are consistent with the major phases used in BDCP planning.

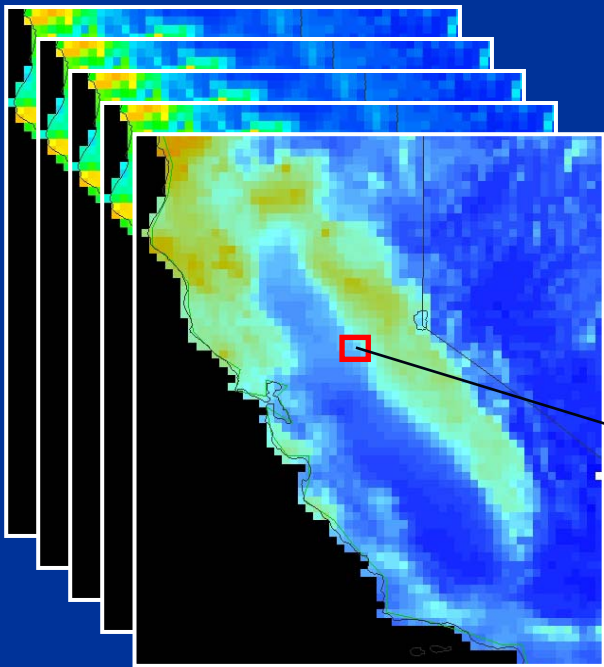
Scenario Selection Approach



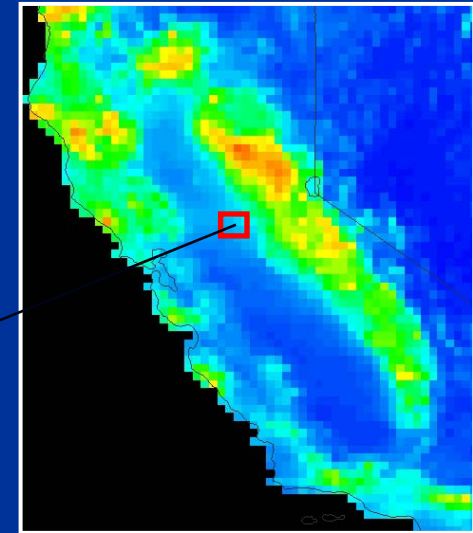
- Develop quadrants or statistical regions of change (Q1 thru Q5)
- Identify projections contained within representative regions
- Utilize all projections within regions to develop scenarios
- Apply process for every grid cell (automated process)

Climate Scenario Development: Example

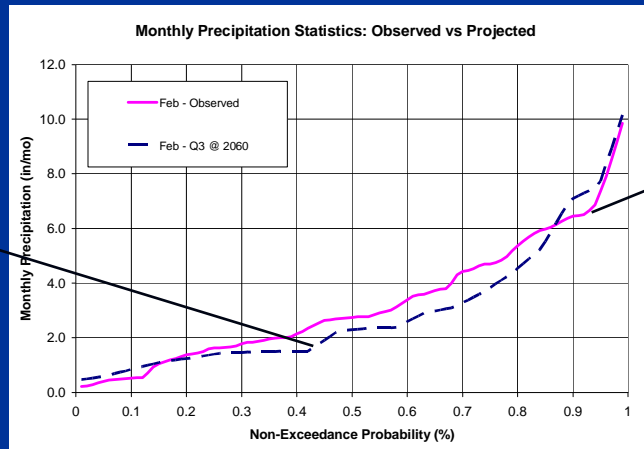
GCM Projections



Observed Precip

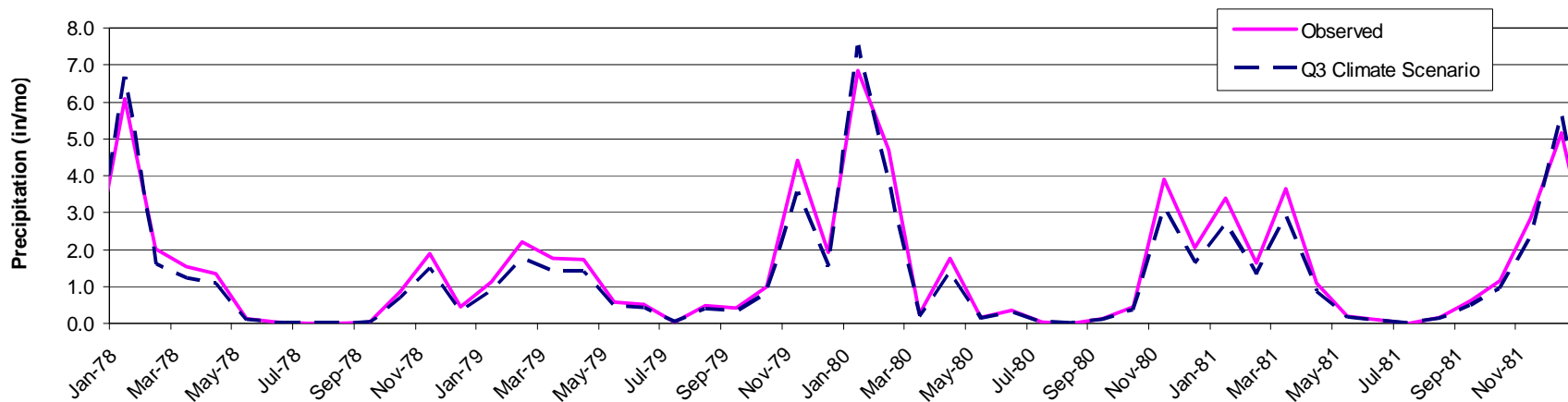


Quantile Mapping:
Projection & observed



Adjusted Precip Time Series

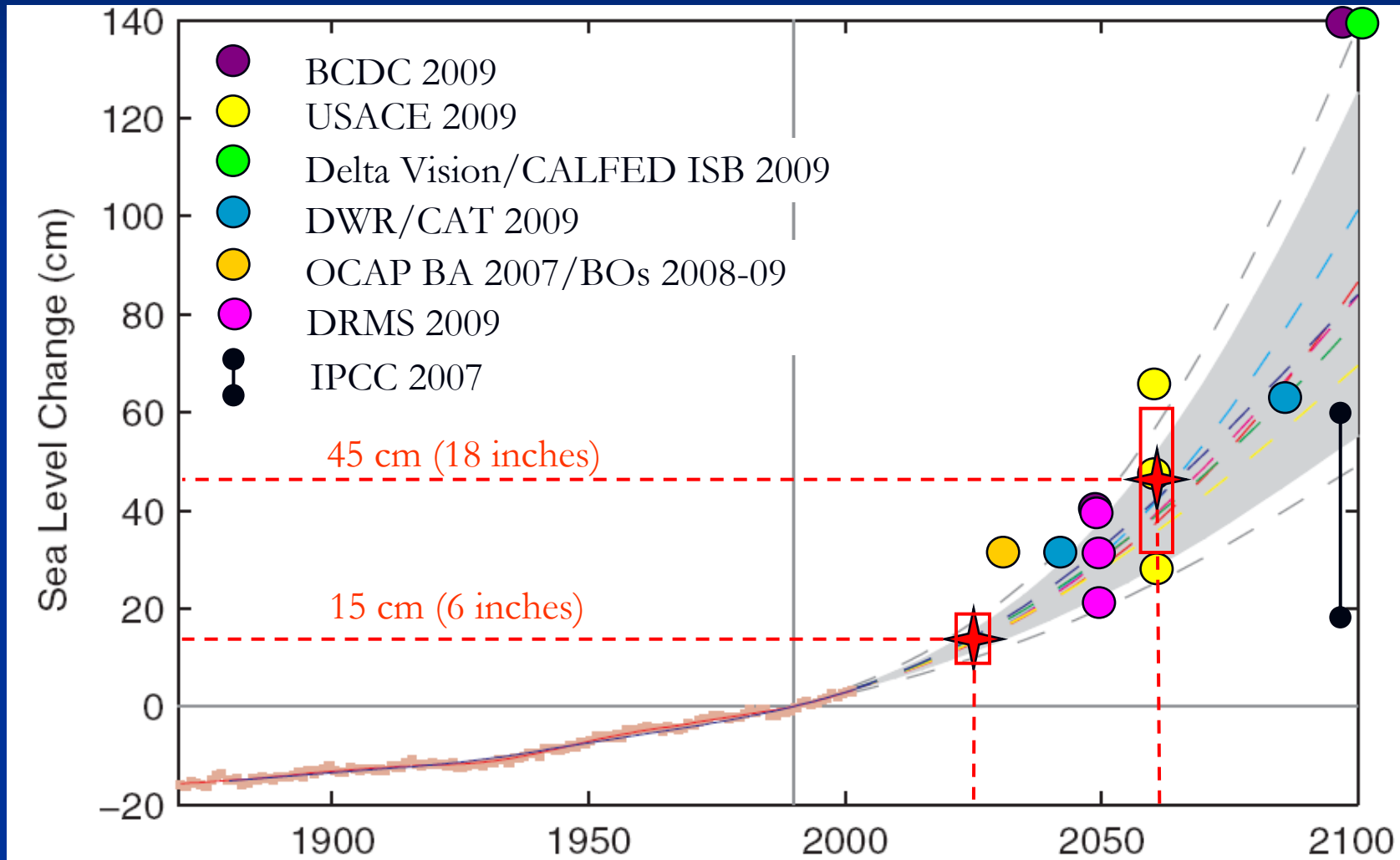
Observed and Projected Precipitation Time Series



Sea Level Rise Considerations

- IPCC AR4 estimates are considered “low”
 - Do not include dynamic instability in Greenland and Antarctica ice sheets
 - Under-predict recent observed sea level rise rates
- Delta Vision/CALFED ISB recommended using Rahmstorf (2007) approach
 - semi-empirical relationship to global air temperature
 - 70-100 cm (28-40 inches) by 2100, full uncertainty range 50-140 cm (20-55 inches)
 - 12-18 cm (5-7 inches) by 2025, 30-60 cm (12-24 inches) by 2060
- CAT 2008 applied Rahmstorf’s approach using air temp from the 12 CAT scenarios
 - Similar to range from full 112 projections at 2025 and 2060; but lower at 2100
- COE issued guidance this year
 - High, medium, and low estimates
 - High estimates:
 - 1.4 m (~4.5 ft) by 2100, ~60 cm (2 ft) by 2060, ~20 cm (0.6 ft) by 2025
- BCDC evaluated two scenarios
 - 40 cm (~16 inches) by 2050
 - 1.4 m (~55 inches) by 2100

Sea Level Rise Estimates from Rahmstorf (2007)



Climate Change Uncertainty and Incorporation in Physical Modeling

		Uncertainty in Regional Climate Change: Scenarios (Quadrant Approach)					
Uncertainty in Sea Level Rise	SLR (ft)	No Climate Change	Q1	Q2	Q3	Q4	Q5 (central)
	0.0	NT, ELT, LLT	S	S	S	S	S
	0.5 (central)	S	ELT	ELT	ELT	ELT	ELT
	1.0	S ?					
	1.5 (central)	S	LLT	LLT	LLT	LLT	LLT
	2.0	S ?					

NT = Near-Term; ELT = Early Long-Term; LLT = Late Long-Term; S = Sensitivity analysis; FNA = Future No Action



CALSIM II & DSM2
(FNA + Alternatives)



CALSIM only
(FNA + Alternatives
bracketing analysis)



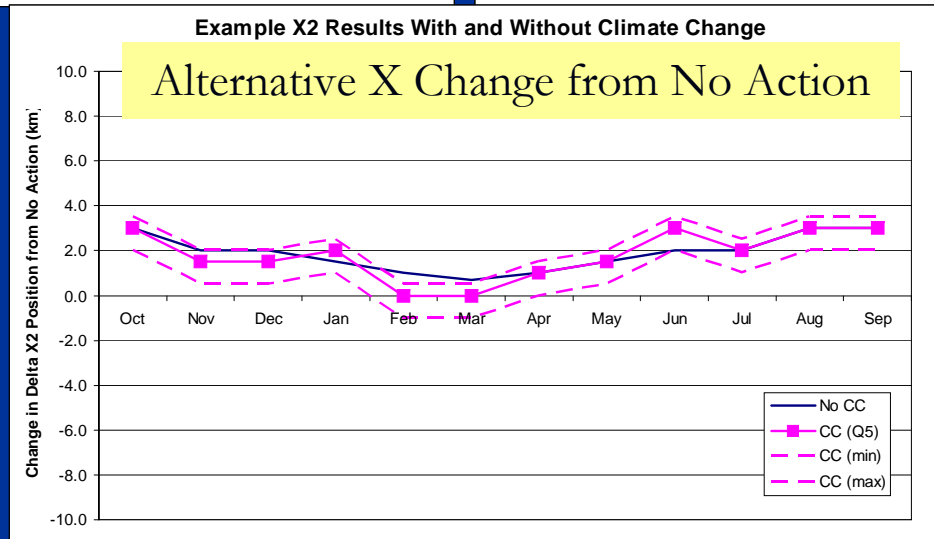
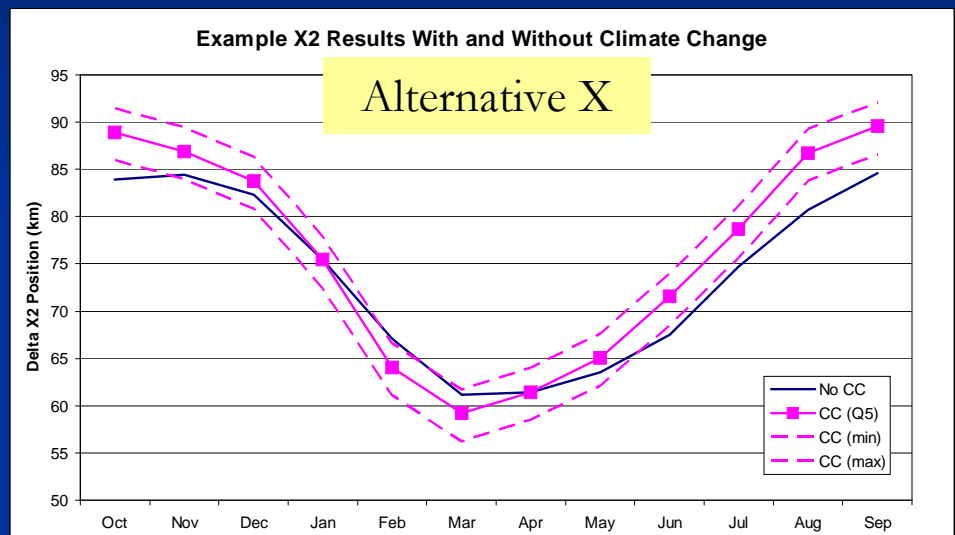
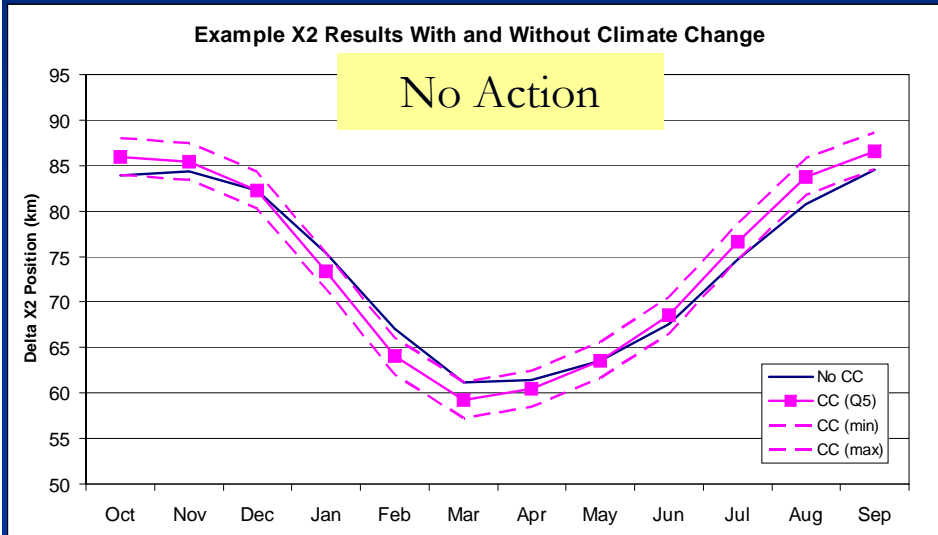
Sensitivity Analysis
(FNA only)



No modeling

Making Use of Climate Change Results

- Analysis teams will have results from scenarios
 - Without climate change, mid-range scenarios, and bracketing scenarios



Next Steps

- Management review of climate change methodology proposal
- Agency legal review for NEPA, CEQA, and ESA compliance
- Review schedule implications
- Certain technical aspects beginning immediately